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Standard Specification for MALLEABLE IRON CASTINGS¹

This Standard is issued under the fixed designation A 47; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal.

1. Scope

1.1 This specification² covers ferritic malleable irons used in general engineering castings for service at both normal and elevated temperatures.

NOTE 1—As a guide for a continuous service at elevated temperatures, the high-temperature characteristics for a number of ferritic malleable irons are given in the Appendix.

NOTE 2—The values stated in U.S. customary units are to be regarded as the standard.

2. Classification

2.1 The malleable irons covered by this specification are classified into two grades according to their tensile properties: Grades 32510 and 35018.

NOTE 3—The first three digits of the grade designation indicate the minimum yield strength ($\times 100$ psi) and the last two digits indicate the minimum elongation (percent in 2 in.).

3. Basis of Purchase

3.1 The purchase order for castings ordered under this specification shall stipulate the grade of malleable iron and any options, exceptions, or additions to the basic requirements of this specification.

4. Materials and Manufacture

4.1 The malleable iron may be made of any composition and by any combination of melting, casting, and heat treating processes that will develop the structural, mechanical, and other requirements of the specification.

5. Physical Requirements

5.1 *Microstructure*—The microstructure of the malleable iron shall consist of temper carbon nodules distributed through a ferritic matrix and shall be free from excessive pearl-

ite, massive carbides, and primary graphite.

5.2 *Tensile Properties*—Tensile test results, obtained in accordance with Section 10 shall conform to the requirements prescribed in Table 1.

6. Dimensions and Permissible Variations

6.1 The castings shall conform substantially to the dimensions given on drawings furnished by the purchaser, or to the dimensions predicated by the pattern(s) supplied by the purchaser, or as agreed upon in specific cases to gages supplied by the purchaser. Variation in any solid dimension will be permitted, as shown in the Table 2, unless otherwise agreed upon by foundry and purchaser.

7. Workmanship and Finish

7.1 The castings shall have no defects that would be detrimental to subsequent processing or to the service for which they are intended. Their surface shall be reasonably smooth and shall be free from scale and burned-on sand.

7.2 No repairing, plugging, or welding of any kind shall be permitted, unless specific permission has been granted by the purchaser. Castings that have been repaired by welding shall be reannealed so that their microstructure will comply with 5.1.

NOTE 4—When malleable iron castings are welded, recognition should be taken of the fact that, without a post-weld anneal, very substantial reductions in ductility, impact resistance, and machinability may result in the vicinity of the weld.

¹This specification is under the jurisdiction of ASTM Committee A-4 on Iron Castings.

Current edition effective Sept. 13, 1968. Originally issued 1904. Replaces A 47 - 66 T.

²For ASME Boiler and Pressure Vessel Code applications see related Specification SA-47 in Section II of that Code.

8. Sampling

8.1 Tension Test Specimen:

8.1.1 The tension test specimens shall be cast to the form and dimensions shown in either Fig. 1 or Fig. 2, in the same kind of molding material used for the production castings. At least three such specimens shall be cast from a representative ladle of iron either from each batch-melted heat or, in continuous melting, from each 4-h pour period during which the purchaser's castings were poured, or as otherwise agreed by manufacturer and purchaser.

8.1.2 All test specimens shall be suitably identified with the designation of either the batch-melted heat or the pour period of a continuous heat.

8.1.3 All test specimens shall be heat treated in regular production furnaces as nearly as possible with those castings which were cast during the same heat or pour period.

9. Number of Tests and Retests

9.1 The foundry shall test at least one annealed tension specimen from each set cast in accordance with 8.1.1 and shall record in permanent records the results, with the permissible exception of those bars containing obvious casting defects. Such records, covering those operating periods during which the purchaser's castings were produced, shall be available for examination by the purchaser or his authorized representative.

9.2 When so stipulated in the order, the purchaser's representative shall be permitted to select and test a reasonable number of tension specimens cast and annealed during that operating period when the subject castings were produced. The foundry shall keep such specimens available to the purchaser's representative up to 6 weeks after the date on which they were cast. The purchaser shall notify the foundry within 2 weeks after taking any such specimens if his test results fail to comply with the specified values.

9.3 In case of failure of the first test specimen to meet the tensile requirements, a companion specimen from the same lot shall be tested. If the tensile values of the retest are satisfactory, the castings shall be considered acceptable with respect to strength requirements. Failure of a second test specimen that

contains no obvious flaws and which fractures within the 2-in. or 50-mm gage length shall be a basis for rejection of the lot.

10. Methods of Test

10.1 Tension Test Specimen:

10.1.1 Unless otherwise agreed upon, the tension test shall be performed on unmachined specimens. If it is agreed that a machined specimen be used, the tensile specimens shall be machined from the cast bars to the dimensions for a ½-in. (12.7-mm) round specimen as shown in Fig. 8 of ASTM Method E 8, Tension Testing of Metallic Materials.³

10.1.2 The gage length of the tension specimens shall be 2.00 ± 0.01 in. (50.8 ± 0.3 mm).

10.1.3 The diameter used to compute the cross-sectional area shall be the average between the largest and smallest diameters at that section of the 2-in. gage length having the smallest diameter and shall be measured to the nearest 0.001 in. (0.025 mm). No cast bar having a mean diameter less than 0.590 in. (15.0 mm) shall be accepted for test.

10.2 *Speed of Testing*—After reaching a stress equivalent to approximately half of the anticipated yield stress, the speed of the moving head of the testing machine shall not exceed 0.50 in./min (12.7 mm/min) up to the yield stress, and above this the speed shall not exceed 2.0 in./min (50.8 mm/min) through the breaking load.

10.3 *Yield Strength and Yield Point*—While the values for yield point and yield strength are not identical, they are sufficiently close for most applications of ferritic malleable irons to be used interchangeably. They may be determined by any of the approved techniques described in ASTM Method E 8, Sections 5.3 and 5.4. If determined as yield strength, that stress producing an extension under load of 0.01 in. (0.25 mm) over the 2-in. gage length (for example, 0.5 percent extension) or an offset of 0.2 percent shall be taken as the yield stress, which shall be converted to yield strength by dividing by the original cross-sectional area of the gage length found in accordance with 10.1.3. It

³ Annual Book of ASTM Standards, Parts 5, 6, and 31.

shall be reported to the nearest 100 psi (0.69 MPa). In accurate or referee work, yield strength shall be determined as the stress which produces an extension under load of 0.5 percent of the gage length.

10.4 Tensile Strength—The tensile strength shall be the maximum load carried by the specimen during the test divided by the original cross-sectional area of the gage length, as found in accordance with 10.1.3. It shall be reported to the nearest 100 psi.

10.5 Elongation—The increase in gage length after fracture of a tensile specimen, measured to the nearest 0.01 in., expressed as a percentage of the original gage length, is the elongation. It shall be reported to the nearest 0.5 percent in 2 in.

10.6 If fracture occurs at or outside the gage marks, the test may be discarded and a new specimen tested.

11. Inspection

11.1 The inspector representing the purchaser shall have access, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise stated in the order, and shall be so conducted as not to interfere unnecessarily with the operation of the producer.

12. Rejection and Resubmission

12.1 Any castings rejected because of im-

proper heat treatment may be reprocessed once by the foundry. Such reheat-treated castings shall be inspected again and if found to be adequately heat treated shall be accepted; if not, they shall be finally rejected.

12.2 Material that shows definite injurious defects subsequent to its acceptance at the manufacturer's foundry may be rejected. The purchaser shall notify the foundry within 6 months after receipt of the lot of any and all claims of failure of the material to comply with this specification. Such defective castings shall be replaced by the foundry.

13. Certification

13.1 When agreed upon in writing by the purchaser and the seller, a certification shall be made the basis of acceptance of the material. This shall consist of a copy of the foundry's test report or a statement by the seller, accompanied by a copy of the test results, that the material has been sampled, tested, and inspected in accordance with the provisions of this specification. Each certification so furnished shall be signed by an authorized agent of the seller or the foundry.

14. Marking and Shipping

14.1 The identification mark of the foundry and the pattern numbers assigned by the purchaser shall be cast on all castings, of sufficient size, in such positions that they will not interfere with the further processing and service of the castings.

14.2 The castings shall be packed in accordance with commercial practice adequate to ensure acceptance and safe delivery by the carrier for the mode of transportation employed.

SUPPLEMENTARY REQUIREMENTS

S1. Special Conditions

S1.1 If agreed upon in writing by foundry and purchaser, the malleable iron castings may be required to meet special conditions as to soundness, hardness or other property, dimensions, surface quality, or a combination of conditions.

S2. Test Lugs

S2.1 If requested in writing or if included

on the pattern(s) or pattern drawing(s), test lugs may be cast on all castings of sufficient size to permit their incorporation. The size of such lugs shall be proportional to the thickness of the casting. On castings over 24 in. (610 mm) in length, a test lug shall be cast near each end. The location of test lugs shall be such as not to interfere with any subsequent processing of the castings. The purchase order shall stipulate whether the foundry's

inspector or the purchaser's inspector shall break, inspect, and pass judgement on the fracture quality of these test lugs.

S3. Destructive Tests

S3.1 At the option of the purchaser or his representative, a casting of each design ordered may be tested to destruction, or otherwise broken up, to determine the presence of any manufacturing condition which might be

detrimental to the serviceability of the casting.

S4. Special Tension Specimens

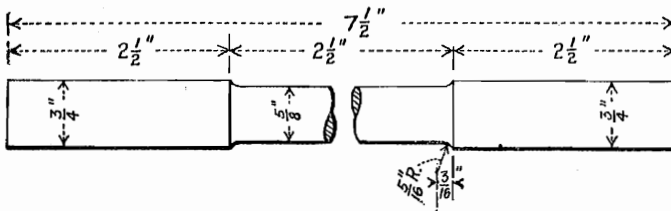
S4.1 If tension specimens are to be machined from castings, their location in the casting, the specimen dimensions, and the required properties shall be agreed upon in writing by foundry and purchaser.

TABLE 1 Tension Test Requirements

	Grade 32510	Grade 35018
Tensile strength, min, ksi (MPa)	50 (345)	53 (365)
Yield strength, min, ksi (MPa)	32 (224)	35 (241)
Elongation, min, percent in 2 in. or 50 mm,	10	18

TABLE 2 Permissible Variations in Any Solid Dimension

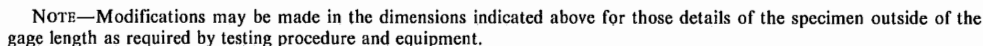
Size		Tolerance	
in.	mm	in.	mm
Up to 1	25.4	$\pm \frac{1}{32}$	± 0.8 mm
1 up to 6	25.4 to 152.4	$\pm \frac{1}{16}$	± 1.6 mm
6 to 12	152.4 to 304.8	$\pm \frac{1}{8}$	± 3.2 mm
12 to 18	304.8 to 457.2	$\pm \frac{3}{32}$	± 4.0 mm
18 to 24	475.2 to 609.6	$\pm \frac{3}{16}$	± 4.8 mm
24 to 36	609.6 to 914.4	$\pm \frac{1}{8}$	± 5.6 mm



Metric Equivalents

in.	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$2\frac{1}{2}$	$7\frac{1}{2}$
mm	4.8	7.9	15.9	19.0	63.5	190.5

FIG. 1 Tension Test Specimen.



Metric Equivalents

FIG. 2 Alternative Unmachined Tension Test Specimen.

APPENDIX

A1. HIGH-TEMPERATURE CHARACTERISTICS OF MALLEABLE IRON

A1.4 Figs. A2 and A3 present time-elongation curves for typical materials appearing in Fig. A1 and Table 1. These clearly exhibit the three stages frequently reported in the literature. In some of the curves, the first stage is not fully drawn because of the time scales required. The curves in Fig. A2 illustrate changes which occur in the shape of the time-elongation curve at different loads for two groups of ferritic specimens. Values obtained for a minimum elongation rate, that is, the linear or second stage portion of Fig. A2, vary from 0.0017 percent/h for long rupture times to 4 percent/h at the highest stress levels and temperatures. These indicate that for most normal applications a load value can readily be selected to keep elongation within desired limits.

A1.3 Table A1 presents the same information in a different form. Here the least squares estimate, Column 2, accompanied by the load values for 95 percent survivors, Column 1 (lower boundary, Fig. A1) and 5 percent survivors, Column 3 (upper boundary) is given for times of 1000, 10,000, and 100,000 h. In some cases, the 10,000 and 100,000 h

TABLE A1 High-Temperature Stress-Rupture Properties of Ferritic Malleable Irons

NOTE—This table shows confidence limits for stress values at 1,000, 10,000 and 100,000 h, normal distribution is assumed.

Group	Rupture Time, h	Stress Value for Time Indicated, ksi (MPa)		
		Lower Boundary, 95% Survivors, ^a Column 1	Least Squares Estimate ^b Column 2	Upper Boundary, 5% Survivors, ^c Column 3
Ferritic (A-1, E-1, G-1), at 800 F (427 C)	1 000	23.4 (161.3)	26.4 (182.0)	29.7 (204.8)
	10 000	20.3 (140.0)	23.4 (163.3)	26.8 (184.8)
	100 000	17.7 (122.0)	20.6 (141.9)	24.1 (166.2)
Ferritic (B-1) high carbon, at 800 F (427 C)	1 000	15.5 (106.9)	17.4 (120.0)	19.5 (134.4)
	10 000	12.9 (88.9)	14.9 (102.7)	16.5 (113.8)
	100 000	10.6 (73.1)	12.2 (84.1)	14.0 (96.5)
Ferritic (A-1, B-1, E-1, G-1), at 1000 F (538 C)	1 000	6.0 (41.6)	6.8 (46.2)	7.6 (52.6)
	10 000	4.5 (31.2)	5.2 (35.7)	5.9 (40.9)
	100 000	3.4 (23.4)	3.9 (26.6)	4.6 (31.6)
Ferritic (A-1, B-1), at 1200 F (649 C)	1 000	2.5 (17.0)	2.9 (19.9)	3.4 (23.4)
	10 000	1.8 (12.2)	2.1 (14.8)	2.6 (17.9)
	100 000	1.3 (8.7)	1.6 (10.9)	1.0 (13.8)

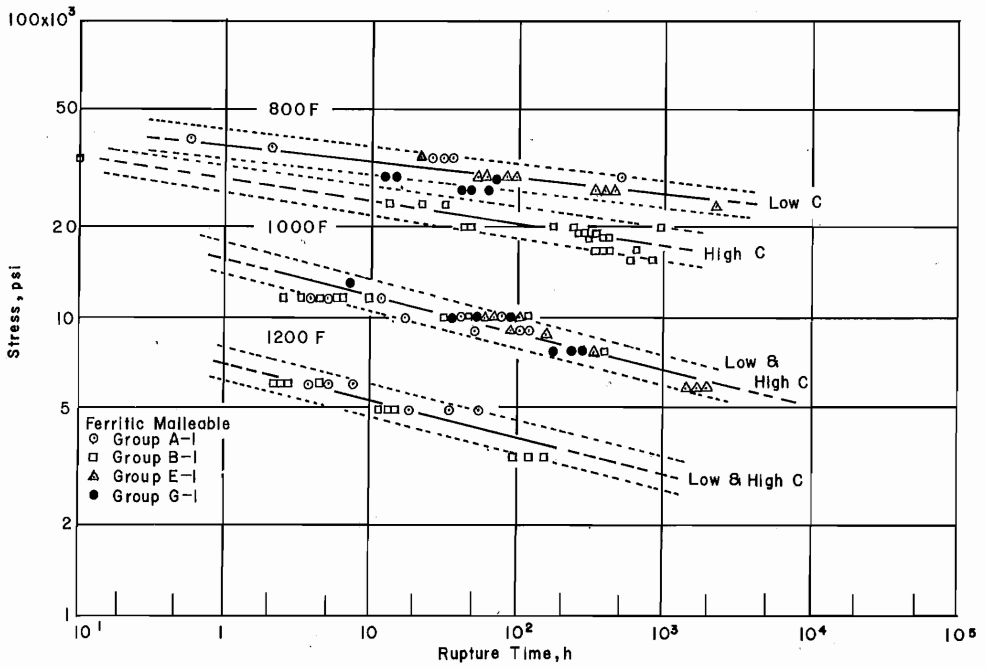
^a 95 percent of the specimens may be expected to last in service at least the time indicated at the loads shown.

^b This is the median load value; 50 percent of the specimens will survive at this load for the time indicated.

^c At these loads, 5 percent of the specimens will exceed the rupture time.

TABLE A2 Chemical Analyses of Test Groups

Group	Grade	Composition, percent					
		Carbon	Silicon	Manganese	Phosphorus	Sulfur	Chromium
A-1	35018	2.21	1.14	0.35	0.161	0.081	...
B-1	32510	2.50	1.32	0.43	0.024	0.159	0.029
E-1	35018	2.16	1.17	0.38	0.137	0.095	0.017
G-1	35018	2.29	1.01	0.38	0.11	0.086	...

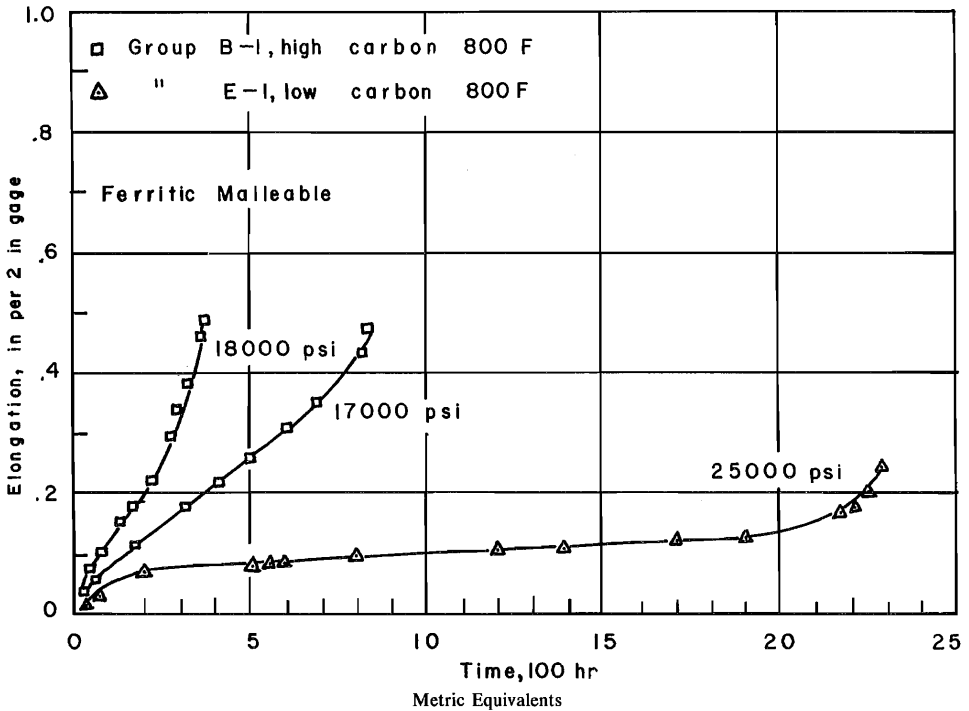


Metric Equivalents

1 psi = 6.89 kPa, 800 F = 427 C, 1000 F = 538 C, 1200 F = 649 C

NOTE—The solid lines are curves determined by the method of least squares from the existing data and are least squares fit to data. The dashed lines define the 90 percent symmetrical tolerance interval. The lower dashed curve, therefore, defines time and load for 95 percent survivors, and the upper dashed curve is the boundary for 5 percent survivors. Normal distribution is assumed.

FIG. A1 Stress Rupture Plot for Ferritic Malleable Iron.



17,000 psi = 117.2 MPa, 18,000 psi = 124.1 MPa, 25,000 psi = 172.4 MPa, 800 F = 427 C

FIG. A2 Time-Elongation Curves for Ferritic Malleable Iron at 800 F (427 C).

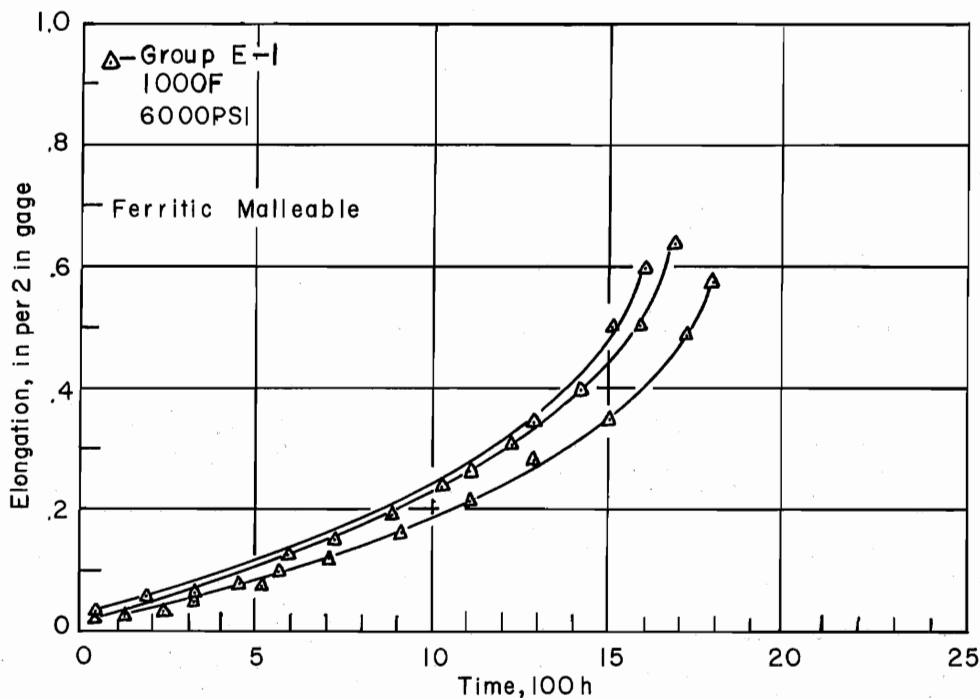


FIG. A3 Time-Elongation Curves for Low-Carbon Ferritic Malleable Iron at 1000 F (588 C) and 6000 psi (41.4 MPa).

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